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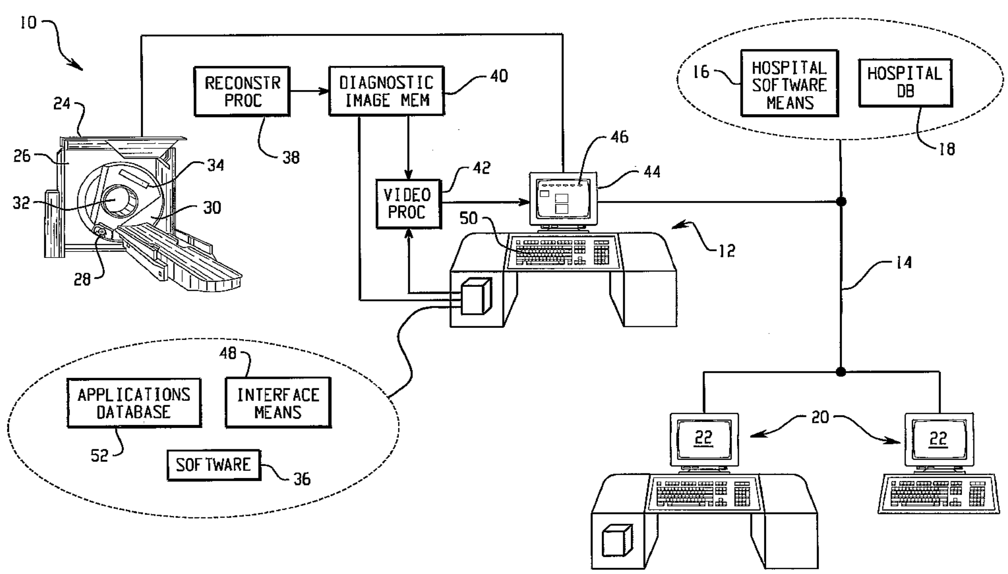
(54) **Title:** WORKFLOW OPTIMIZATION FOR HIGH THROUGHPUT IMAGING ENVIRONMENT



(57) **Abstract:** A medical diagnostic imaging system (10) is coupled to a hospital network (14) to optimize a throughput of a scanner (24). The hospital network includes a hospital records database (18) and a plurality of hospital computers and remote means (20). A workstation (12) is coupled to the scanner (24) and the hospital network (14) and is used to control a scanning process. The workstation (12) includes a display (44), an applications database (52), which is configurable by a user, and an interface means (48) for displaying interactive user interface screens (46) on the display (44). The interface screens (46) allow the user to configure the applications database (52) and interactively control the scanning process.

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WORKFLOW OPTIMIZATION FOR HIGH THROUGHPUT IMAGING ENVIRONMENT

DESCRIPTION

The present invention relates to diagnostic imaging systems and methods. It finds particular application in conjunction with improving the throughput of CT scanners and other diagnostic equipment and will be described with particular reference thereto. However, it is to be appreciated that the invention will also find application in conjunction with improving medical processing efficiency, diagnostic efficiency, and the like.

Multi-slice CT (MSCT) imaging has achieved major technological breakthroughs in a very short period of time. The sixteen slice CT scanner is rapidly becoming the workhorse of the radiology, ET and trauma department. MSCT technology not only enables the acquisition of a large number of CT slices on a routine basis, but also the use of CT to diagnose non-traditional anatomies, e.g. cardiovascular. The advent of multi-slice CT has also opened the possibility of routine CT screening for diagnosing disease at an early, treatable stage.

However, in order for hospitals and imaging centers to fully utilize and tap the power of MSCT, significant workflow bottlenecks need to be overcome. Significant workflow bottlenecks exist in three different areas: (1) patient throughput through the CT scanner, (2) analysis and post-processing of reconstructions numbering more than 1000 images, and (3) storage and archival of CT images.

In a CT scan, the operator first enters the name of the patient, what parameters are needed for the scanning process, including the requested procedure from HIS/RIS, patient's age, patient's weight, requesting physician, scanning with contrast, scanning without contrast, cardiac, etc. After the scanning parameters and patient information are entered, the operator is presented with a large selection of scanning protocols, which come up together on one screen, making the selection of an appropriate scanning protocol a time consuming and difficult task.

Many scans require post processing targeted towards specific disease and/or processes. The permutations and combinations of applications and the distribution of post processing preferences among the physicians is difficult for a clinical department to organize, leading to workflow inefficiencies. The operator manually opens correct post processing application. Currently, some imaging systems open the image processing

package associated with the scanner as the scan is running. However, they wait for user input to activate the package and select the images to be produced.

Regarding archival, a paper log is maintained for each patient and each scanner regarding the number of scans, how the scanner is used, and other such information which is very inefficient and time-consuming.

Typically the physicians are requested to make a number of measurements during scans. Currently, the hospital personnel uses a piece of paper with a list of measurement descriptions. To record each measurement the user must take his hand off the mouse/keyboard and write the result down. Moreover, returning to a measurement that it has been already made is not possible and a new measurement must be taken. This all is very time consuming.

To summarize, using current day procedures, hospitals are only able to examine about thirty patients per day with the newest sixteen slice CT scanners. In order to justify the cost of this equipment, the hospitals want to process fifty patients per day.

There is a need for an automated mechanism that will optimize the scanning workflow. The present invention provides a new and improved apparatus and method which overcomes the above-referenced problems and others.

In accordance with one aspect of the present invention, a medical diagnostic image processing system is disclosed. The medical diagnostic image processing system is coupled to a hospital network, which includes a hospital database and a plurality of hospital computers. A scanner acquires images of a patient. A means is coupled to the scanner and the hospital network to control a scanning process, and includes: a display, an applications database which is configurable by a user, and an interface means for displaying interactive user interface screens on the display, which user interface screens allow the user to configure the applications database and interactively control the scanning process by at least activating icons and buttons displayed thereon.

In accordance with another aspect of the present invention, a method of optimizing a throughput of the diagnostic image processing system is disclosed. The medical diagnostic image processing system is coupled to a hospital network, which includes a hospital database and a plurality of hospital computers. Images of a patient are

acquired by a scanner. A scanning process is controlled from a workstation which is coupled to the scanner and the hospital network, and includes: a display, an applications database which is configurable by a user, and an interface means. The interface screens are displayed on the display to allow the user to configure the applications database and interactively control the scanning process.

One advantage of the present invention resides in an optimization of scanner's workflow. Other advantages reside in streamlining CT examinations, automating the use of patient information to optimize the scanning protocol, improving patient throughput, and improving operational simplicity of advanced post-processing applications to potentially improve diagnosis.

Another advantage resides in an automation of the workflow that is always visible to the operator.

Another advantage resides in an ease of use.

Another advantage resides in time savings due to the directed workflow.

Another advantage resides in real-time post-processing as the data is acquired permitting the physician to review post-processed images when the patient is still on the table and make a decision whether the patient can be released.

Still further advantages and benefits of the present invention will become apparent to those of ordinary skill in the art upon reading and understanding the following detailed description of the preferred embodiments.

The invention may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating the preferred embodiments and are not to be construed as limiting the invention.

FIGURE 1 is a diagrammatic illustration of an imaging system coupled to a hospital network;

FIGURE 2 is a diagrammatic illustration of a portion of the imaging system including coupled to a hospital network;

FIGURE 3 is a more detailed diagrammatic illustration of some elements of the portion of the imaging system and the hospital network depicted in FIGURE 2;

FIGURE 4 is a diagrammatic illustration of one interface screen in accordance with the present invention;

FIGURE 5 is a diagrammatic illustration of another interface screen showing protocol groups;

FIGURE 6 is a diagrammatic illustration of another interface screen showing selected exam protocols;

FIGURE 7 is a diagrammatic illustration of another interface screen, using which the user can modify protocol parameters;

FIGURE 8 is a diagrammatic illustration of another interface screen, on which the user can preview created protocol;

FIGURE 9 is a diagrammatic illustration of another interface screen, using which the user maps the protocols;

FIGURE 10 is a more detailed diagrammatic illustration of some elements of the portion of the imaging system and the hospital network depicted in FIGURE 2;

FIGURE 11 is a more detailed diagrammatic illustration of some elements of the portion of the imaging system and the hospital network depicted in FIGURE 2.

With reference to FIGURE 1, an operation of an imaging system **10** is controlled from an operator workstation **12** which is coupled to a hospital network **14.** The hospital network **14** includes associated software means **16** and a hospital records database **18**. The workstation **12** may be hardwired to the network **14** or may communicate with it wirelessly. In this manner, the workstation **12** can communicate with other hospital workstations or computers or remote means **20**, which are connected to the hospital network **14**, enabling the images and patient records to be forwarded to the appropriate hospital personnel and displayed on associated monitors **22**.

Typically, the imaging system **10** includes a CT scanner **24** including a non-rotating gantry **26**. An x-ray tube **28** is mounted to a rotating gantry **30**. A bore **32** defines an examination region of the CT scanner **24**. An array of radiation detectors **34** is disposed on the rotating gantry **30** to receive radiation from the x-ray tube **28** after the x-rays transverse the examination region **32**. Alternatively, the array of detectors **34** may be positioned on the non-rotating gantry **26**.

Typically, the imaging technician performs a scan using the workstation **12** loaded with software **36.** Diagnostic data from the scanner **24** is reconstructed by a reconstruction processor **38** into electronic image representations which are stored in a diagnostic image memory **40.** The reconstruction processor **38** may be incorporated into the workstation **12,** the scanner **24,** or may be a shared resource among a plurality of scanners and workstations. The diagnostic image memory **40** preferably stores a three-dimensional image representation of an examined region of the subject. A video processor **42** converts selected portions of the three-dimensional image representation into appropriate format for display on a video monitor **44.** The operator controls the scanning process, production and display of images by using an application interface screen or screens **46** which are incorporated into the workstation **12** and displayed on the monitor **44** to guide the operator through the scanning process. An interface means or processor **48** controls the application interface **46.** The operator uses an operator input device, such as a keyboard or mouse **50** to interact with an applications database **52** by navigating the application interface screens **46.**

With continuing reference to FIGURE 1 and further reference to FIGURE 4, the interface screen **46** includes a plurality of icons **56** and buttons **58** to navigate through the interface screen(s) **46** and to control scanning workflow. In one embodiment, the screen **46** further includes a scanner home page **60.** The scanner home page **60** includes icons **62** and buttons **64** which are used to interactively control the scanner **24.**

With reference to FIGURE 3, a protocol optimization means **70** optimizes selecting a correct exam protocol from a plurality of protocols stored in a protocols memory **72** at the hospital database **18.** Generally, there are a number of factors that need to be taken into consideration when choosing the right exam protocol, e.g. the patient's data including patient's age, patient's weight, requesting physician, and scanning parameters including the requested procedure, scanning with contrast, scanning without contrast, which part of the body to scan - cardiac, abdomen, etc.

With continuing reference to FIGURE 3 and further reference to FIGURES 5-6, preferably ahead of time the operator interactively sets up a bank of optimal examination protocols via a protocol configuration means or process **74** which configures optimal protocols by receiving appropriate criteria and optimization parameters supplied by the user. The examination protocols from the protocols memory **72** are displayed on a

protocol groups screen **76** as buttons **80** grouped by the examination region, e.g. ear, head, etc., as shown in FIGURE 5. When the operator clicks on one of the buttons **80** such as a Head button **82**, all protocols available for imaging the head are displayed on a Head Protocol Screen **84**, shown in FIGURE 6. Head protocols **86** are grouped into examination regions such as sinus, dental, etc. The user chooses one of the existing protocols, e.g. sinus, for further configurations.

With reference to FIGURES 7-9, a protocol parameters screen **88** allows the user to enter specific parameters for the chosen protocol, etc. sinus. The user first selects a type of an examination, e.g. clinical scan, by choosing an appropriate entry from a sequence list **90**. The user next specifies parameters for selected sequence, e.g. clinical scan, by flipping through tabs **92**. The contents of exemplary tabs **92** change based on the selected sequence. The user saves created protocol by clicking on button **94** located on the bottom of the screen **88**, and is taken to the next screen, a protocol preview screen **96,** shown in FIGURE 8. If the created protocol is not to user's satisfaction, the user clicks on a back arrow **98** and is taken back to the protocol parameters screen **88** to make further modifications. If the created protocol is to user's satisfaction, the user clicks on a forward arrow **100** and is taken to the next screen, a map protocol screen **102,** shown in FIGURE 9 to finish the protocol configuration process. More particularly, the user maps the created protocol to specific patient's groups such as an age group **104**, a weight group **106**, and the like. The protocols are further mapped to a requesting physician **108** and a requested procedure **110**. Of course, further mapping of the protocols into other categories is also contemplated.

With continuing reference to FIGURE 9 and reference again to FIGURE 3, the user concludes the protocol configuration by using one of buttons **112** located at the bottom of the screen **102**. Preferably, the user clicks on a button Save to save the created optimal protocol in an optimal protocols memory **114** at the hospital database **18**.

With reference again to FIGURES 3 and 4, a protocol selection means **120** limits a number of scanning protocols available for display by the interface means **48** on the display **44**. More specifically, to select the correct exam protocol, prior to each scan, the operator supplies each patient's data and scan parameters, e.g. limiting criteria, by entering the patient data and scanning parameters into the application database **52.** The operator types the patient data, e.g. name, weight, requesting physician, requested procedure, etc.,

into data entry fields **122**, shown in FIGURE 4. The protocol selection means **120** matches the entered information with the information stored in the optimal protocols memory **114** and determines the nature and region of the scan to be performed, the physician and physician's preferences and scans, and other such information. Preferably, as a result, all unmatched protocols are eliminated, and the interface means **48** displays the most appropriate protocols for scanning the specific patient on the monitor **44**. Preferably, the protocol selection means **120** limits the number of protocols between one and three, from which it is quick and easy for the operator to select from.

With continuing reference to FIGURE 3, a post-processing configuration means or process **130** allows users to specify their own specific preferences for acquisition and post processing in an interactive manner. The post-processing configuration means **130** matches the users' preferences with post-processing packages which are stored in a post-processing packages memory **132** at the hospital database **18**. Generally, many examination procedures require standard post-processing, e.g. the spine scanning usually requires MPR, the cardiac study is typically displayed in Cardiac Review package, the dental scans are typically displayed in the Dental application, etc. Some physicians routinely request filming as a part of the post-processing process that might be set up during the post-processing configuration process **130**. Preferably, the user sets up the MPR as a standard post-processing for all spine exams, Cardiac Review package as a standard post-processing for all cardiac exams, filming for specific examinations or requesting physicians, etc. Configured post-processing packages are stored in a post-processing memory or database **134** residing on the workstation **12**. Alternatively, the configured post-processing packages are stored in a database residing on the scanner **24**.

A post-processing means **136** searches the post-processing memory or database **134** for the post-processing package that matches type of scan and other parameters entered by the operator into the data entry fields **122**. The post- processing package is started automatically to generate post-processed images and film as the data is acquired; e.g., the cardiac study is displayed in Cardiac Review package automatically, every spine examination is displayed automatically in real-time MPR, the Dental application is launched automatically for a dental examination, etc. The physician reviews post-processed images when the patient is still on the table and makes a decision whether

the patient can be released. Preferably, the images and other data are automatically sent wherever it needs to go, e.g. to the reviewing physician's workstation.

With continuing reference to FIGURE 3, the post-processing configuration means **130** includes a visualization configuration means **138**. Preferably, for the study of the specific region, e.g. abdomen, the visualization configuration means **138** determines the optimal screen layout, the rendering mode for each viewport, the specific parameters for each viewport (e.g., classification for volume rendering), the display orientation, image zoom/pan, the slab thickness, restriction of volumes of interest, filming, storage, and report parameters. Furthermore, preferably, in determining the level and zoom, slice and slab thicknesses, windowing, and the like, the visualization configuration means **138** takes into consideration the preferences of each requesting physician. Visualization parameters are stored in a visualization parameters memory or database **140**. A visualization means **142** automatically displays the images on the screen with the right zoom, right filter, right report parameters, etc., based on the data entered by the operator for a specific patient. The physician is able to review the images very quickly without the need to reconstruct again the region of examination and/or film right away with right zoom, filter, etc.

With reference again to FIGURE 2, a parameters optimization means **150** automatically optimizes various scan parameters such as the kV and mA for the protocol selected by the protocol selection means **120**, saving the operator the time to make these selections depending on clinical study. Preferably, the optimization criteria includes scanning mode, scan duration, patient dose, required image quality, etc. In one embodiment, the patient doze might be optimized depending on where the radiation is coming from, e.g. from the side or other direction, according to the size of the patient, the region of the scan, clinical study, e.g. trauma, required image quality, etc.

With continuing reference to FIGURE 2, a pre-fetch means **152** searches a previous scan database **154** residing at the hospital database **18** for earlier scans of the same patient. The pre-fetch means **152** retrieves previous scans, which have been stored from previous exams from the same or different modality, into the workstation on which the physician examines the current scans of the patient. Preferably, the pre-fetch means **152** performs pre-fetch of the previous scans automatically when the patient data is entered by the operator at the beginning of the exam, without waiting for the previous scans to be requested. Preferably, the earlier images are directly sent to the physician's workstation

and registered by using one of known pre-registration techniques to display earlier and current scans side by side on the monitor **22**. Alternatively, the earlier images are directly sent to the physician's workstation only if requested by the reviewing physician.

Preferably, the pre-fetch means **152** determines if there are earlier related scans, e.g., whether the current examination is one of a series of follow-up examinations, and determines the parameters and protocols used in the previous scans. The previously used parameters and protocols are offered to the operator to be used in conjunction with the protocol selection and parameter optimizing steps. The operator reviews what parameters were entered when the patient was previously scanned, e.g. age, weight, etc. Preferably, the operator uses the same parameters or, as an alternative, the operator adjusts the previously entered parameters. Use of the same parameters for the new study is very useful for routine exams, e.g. lungs scan, since it is desirable to perform the routine exams in the same way as it was done few years ago.

With continuing reference to FIGURE 2, a slab review means **160** merges groups of slices into thicker slabs so that fewer slabs need to be examined. Preferably, the operator interactively supplies a thickness of the slab to a thickness determining means **162** to view slices in slabs of the selected thickness. The operator reviews slabs with an adjustable speed in any direction. If any slab shows features of interest, it is interactively separated by the operator back into its component slices in real-time. Preferably, the slab review means **160** provides real-time navigation in axial/coronal/sagittal and any general direction through the volume using variable-thickness slab with MPR/MIP/3D/4D rendering.

A streamlined directed workflow or workflow means or process **170** integrates all functional components of the interface means **48**. The workflow means **170** leads the operator through the scanning process by presenting to the operator step by step process for applications and providing for quick, easy scan set up, scan acquisition, and scan completion. In one embodiment, illustrated in FIGURES 5-9, the workflow means **170** leads the operator through generating a new protocol by a use of tabs **172** positioned in a specific logical order, buttons such as the Save button **94** of FIGURE 7, and the like.

A log means **180** receives the patient and scan information and writes the information into a digital log book **182.** The digital log book **182** is stored at the interface means **48** for each patient and each scanner regarding the number of scans, how the

scanner is used, and other such information. The log means **180** selects which information needs to be archived into an archive **184**. Preferably, if a paper copy is to be stored, the log means **180** initiates printing the information stored in the digital log book **182** in a regular intervals in the format to which the hospital personnel is accustomed to.

A remote statistics means **190** enables the remote access of the scanner **24** from the remote means **20** for optimizing scanner usage and increasing patient throughput. In addition, it enables statistical analysis of the scanners for planning and budgeting purposes. The user initiates mining of the digital log book **182** to find out more about how the scanner is used and determine how yet greater efficiencies can be achieved. Preferably, hospital administrators can estimate and optimize scanner usage, distribute patient load between two or more scanners in a multi-scanner environment, and the like.

A mobile protocol means **192** allows the physician or others to remotely specify and preload the selected scan protocols by using the remote means **20** such as PDA, computer, the web, or the like, into the hospital network system **14**. Preloaded protocols are stored in a mobile protocols memory **194**. The interface means **48** automatically uploads the information for each patient to the CT scanner **24**, eliminating the operator protocol selection step. Alternatively, the information is uploaded directly to the CT scanner.

A measurement protocol configuration means **200** configures a work list of measurements. Often, as a part of an imaging examination, the physician needs to have measurements based off the centerline and cut planes along a vessel (or group of vessels), which are normal to the centerline.

With continuing reference to FIGURE 2 and further reference to FIGURE 10, measurements, which can be performed by using the imaging system **10**, are stored in a measurement database or memory **202** residing at the hospital database **18** and typically include the following exemplary measurements:

(a) Area Measurement **204a** which is a measurement of an area of a cut plane at a specific place along the centerline;

(b) Angle Measurement **204b** which is a measurement of an angle between three points along the centerline;

(c) Diameter Measurement **204c** which is a measurement of a diameter of the vessel on a cut plane at a specific point along the centerline;

(d) Tortuosity Measurement **204d** which is a measurement defined with two or three points along the centerline to specify the amount of twist in the vessel;

(e) Volume Measurement **204e** which is a measurement defined with two cut planes along the centerline of the vessel;

(f) Length Measurement **204f** which is a measurement of a distance along the centerline between two points on the centerline;

(g) Question Asked **204g** which a question that the user is requested to answer;

(h) Description Needed **204h** which is a question that the operator might asked that takes a few words to answer.

A measurement description memory or database **210** includes a description for each measurement category **204a-f** which each is linked to each measurement category to help the user in setting up and making the measurement. A question memory **212** includes a list of answers, empty data entry fields, and the like which are linked to the Question **204g** and Description **204h** categories to help the user in answering questions asked.

The user interactively selects the measurements from the measurements database **202** via a measurements selection means **220.** For a specific measurement protocol, all of the available measurements might be selected or only a part of the available measurements might be selected from the measurements database **202.** A reference image selection means **222** selects a reference image showing an example vessel of which the measurements are to be made on. A plurality of default reference images is stored in a default image memory **224** at the hospital database **18.** Preferably, correct reference image is displayed automatically in response to the user's selection of the measurements. Alternatively, the user interactively chooses one of the reference images that is more to his/her liking. The reference image is displayed on the monitor **44** providing a visual indication of where each individual measurement is placed. Preferably, each measurement is linked to a different marker and only the current measurement appears on the reference image. The user interactively provides an input to a reference image measurement adjustment means **226** by adjusting the measurement marker in the displayed reference image. Configured measurement protocols are stored in a measurements protocols memory **228.**

With reference to FIGURE 11, a measurement means **230** performs actual measurements. A measurement protocol means **232** automatically selects the correct measurement protocol based on the operator data entries. A measurement application means **234** extracts the centerline, normal cut planes within a vessel, and the like from the patient's image using one of known measurement application packages. A measurement calculating means **236** performs the actual measurements by retrieving measurements configured in the selected protocol. A description loading means **238** loads linked measurement description and/or corresponding answers/data entry fields for each measurement category **204a-h**. The monitor's screen automatically changes for each measurement. A measurement interaction means **240** accepts the entry from the operator to adjust actual measurements, e.g. change the number of points along the centerline, etc. A measurements updating means **242** automatically updates the measurements to the value which is shown on the screen is showing. The updated measurements are stored in an actual measurements memory **244**. When all the measurements for the selected protocol are completed, the operator preferably prints out the entire list of measurements into a report via a report generating means **246**.

The invention has been described with reference to the preferred embodiments. Modifications and alterations may occur to others upon a reading and understanding of the preceding detailed description. It is intended that the invention be constructed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

CLAIMS

Having thus described the preferred embodiments, the invention is now claimed to be:

1. A medical diagnostic imaging system **(10)** for acquiring images of a patient, coupled to a hospital network **(14)**, which includes a hospital database **(18)** and a plurality of hospital computers **(20)**, the system **(10)** comprising:

a means **(12)** for controlling the imaging system **(10)**, which controlling means **(12)** is coupled to the imaging system **(10)** and the hospital network **(14)** and includes:

a display **(44)**,

an applications database **(52)** which is configurable by a user, and

an interface means **(48)** for displaying interactive user interface screens **(46)** on the display **(44)**, which user interface screens **(46)** allow the user to configure the applications database **(52)** and interactively control the imaging system **(10)** by at least activating icons **(56)** and buttons **(58)** displayed thereon.

2. The system as set forth in claim 1, wherein the interface means **(48)** includes:

a protocol configuration means **(74)** for configuring optimal examination protocols in response to receiving optimization parameters entered by the user into at least data entry fields **(122)** displayed on the user interface screens **(46)**.

3. The system as set forth in claim 2, further including:

a protocol selection means **(120)** for choosing examination protocols in response to receiving patient's limiting parameters entered by the user into data entry fields **(122)** displayed on the user interface screens **(46)**, and displaying the chosen examination protocols on the display **(44)** from which the user selects a correct examination protocol.

4. The system as set forth in claim 1, wherein the interface means **(48)** includes:

a post-processing configuration means **(130)** for configuring post-processing packages in response to receiving acquisition and post-processing parameters entered by the user into at least data entry fields **(122)** displayed on the user interface screens **(46)**.

5. The system as set forth in claim 4, wherein the protocol selection means **(120)** includes:

a post-processing means **(136)** for automatically launching a correct post-processing package which matches patient's limiting parameters entered by the user into data entry fields **(122)**.

6. The system as set forth in claim 5, wherein the post-processing means **(136)** generates post-processed images simultaneously as the images of the patient are acquired.

7. The system as set forth in claim 6, wherein the post-processed images are automatically sent to a reviewing physician's hospital computer **(20)**.

8. The system as set forth in claim 4, wherein the post-processing configuration means **(130)** includes:

a visualization configuration means **(138)** for configuring visualization parameters in response to receiving acquisition and post-processing parameters entered by the user into the data entry fields **(122)**.

9. The system as set forth in claim 8, wherein the post-processing means **(136)** includes:

a visualization means **(140)** for automatically launching visualization parameters which match patient's limiting parameters entered by the user into data entry fields **(122)**.

10. The system as set forth in claim 1, further including:

a scanner **(24)** for acquiring images of a patient; and

a protocol selection means **(120)** for selecting examination protocols in response to receiving patient's limiting parameters entered by the user into data entry fields **(122)** displayed on the user interface screens **(46).**

11. The system as set forth in claim 10, wherein the interface means **(48)** includes:

a parameters optimization means **(150)** for automatically selecting optimization parameters based on the selected examination protocol to correct at least one of:

voltage supplied to the scanner **(24)**,
amperage supplied to the scanner **(24)**, and
a doze supplied to the patient.

12. The system as set forth in claim 10, wherein the interface means **(48)** includes:

a pre-fetch means **(152)** for searching the hospital database **(18)** for previous scans and examinations of the patient, wherein the previous scans and examinations are automatically sent to the physician's hospital computer **(20)**.

13. The system as set forth in claim 12, wherein the parameters and protocols of previous examinations are used in the step of selecting the examination protocol.

14. The system as set forth in claim 12, wherein the previous scans have been generated at a different modality and the system **(10)** utilizes an auto registration technique to display the previous and current scans at the physician's computer **(20)**.

15. The system as set forth in claim 10, wherein the interface means **(48)** includes:

a slab review means **(160)** for merging image slices acquired by the scanner **(24)** into slabs of selected thickness which is interactively supplied by the user.

16. The system as set forth in claim 10, wherein the interface means **(48)** includes:

a log means **(180)** for automatically recording selected scanner's information including at least patient's information and scanner's running time into a digital log book **(182)**.

17. The system as set forth in claim 16, further including:

a remote statistics means **(190)** for remotely accessing and mining the digital log book **(182)**.

18. The system as set forth in claim 10, further including:

a mobile protocol means **(192)** for remotely specifying and loading examination protocols into the hospital database **(18)**, wherein the interface means **(48)** automatically uploads the examination protocols into the scanner **(24)**.

19. The system as set forth in claim 1, further including:

a measurement protocol configuration means **(200)** for configuring measurement protocols, which means **(200)** includes:

a measurement selection means **(220)** for selecting a list of measurements to be performed for each measurement protocol; and

a reference image means **(222)** for selecting a reference image which provides a visual indication of where each individual measurement is placed.

20. The system as set forth in claim 19, further including:

a measurement protocol means **(232)** for selecting a correct measurement protocol in response to receiving patient's limiting parameters entered by the user into data entry fields **(122)** displayed on the user interface screens **(46)**;

a measurement calculating means **(236)** for performing actual measurements; and

a measurement updating means **(242)** for storing the actual measurements.

21. The system as set forth in claim 1, wherein the interface means **(48)** includes:

a workflow means **(170)** for guiding the user through the imaging process which workflow means **(170)** presents the user interface screens **(46)** to the user in a subsequent order and prompts the user to enter data including at least patient's data, requested procedure and requesting physician.

22. A method of optimizing a throughput of the diagnostic image processing system **(10)** of claim 1.

23. In a medical diagnostic imaging system coupled to a hospital network **(14)** which interconnects a hospital archive database **(18)**, computers **(20)**, computer displays **(22)**, and diagnostic scanners **(24)**, a computer (12) programmed for at least one of:

(a) selecting a limited number of protocols from a menu of available protocols in accordance with entered patient size, patient age, radiologist identification, radiologist preferences, and the nature and region of patient to be scanned, and generating an operator interactive display of the limited number of protocols;

(b) automatically commencing post-processing during data acquisition in accordance with the types and format of images most commonly generated for a selected scan protocol;

(c) optimizing a tube voltage and tube current in accordance with an operator selected protocol;

(d) searching the hospital archive database for scans of a patient currently undergoing examination and routing the archive scans directly to the display terminal **(22)** of a diagnosing radiologist, automatically without waiting for a transfer request;

(e) searching the hospital archive database to determine if a current examination is a follow-up examination, determining parameters and scan protocols used in prior scans, and setting the scanner **(24)** to conduct the follow-up examination using the same parameters and scan protocols;

(f) searching the hospital archive database to determine preferences of a diagnosing radiologist and adjusting level, zoom, slice and slab thicknesses, windowing,

and other display characteristics in accordance with the retrieved preferences of the diagnosing radiologist;

(g) merging groups of slice images into a smaller number of slab images, sequentially displaying the slab images, and displaying the individual slice images corresponding to each slab image designated by a diagnosing radiologist;

(h) generating a series of prompts to an operator to lead the operator sequentially through an imaging procedure;

(i) for each scanner **(24)**, automatically generating a digital log book by collecting entered patient information and scan information for each patient examined by the corresponding scanner;

(j) at the beginning of a scan procedure, automatically uploading scan protocol information previously submitted from a remote computer or PDA.

24. The system as set forth in claim 23, wherein a computer is programmed to perform all of steps (a)-(j).

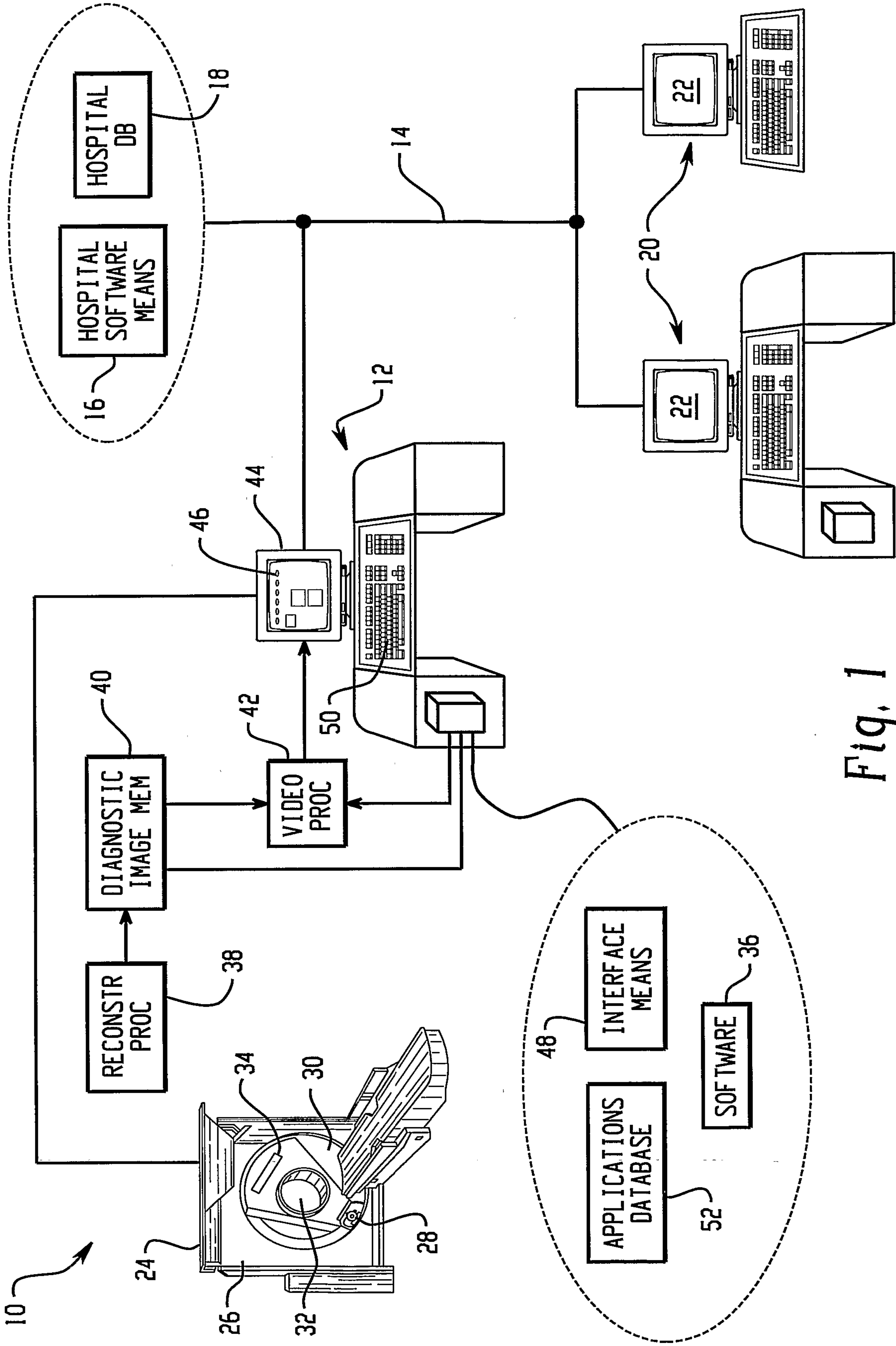
HOSPITAL SOFTWARE MEANS
16
HOSPITAL DB
18
14
20
22
22
12
44
46
50
DIAGNOSTIC IMAGE MEM
40
VIDEO PROC
42
RECONSTR PROC
38
INTERFACE MEANS
48
SOFTWARE
36
APPLICATIONS DATABASE
52
10
24
26
28
30
32
34

Fig. 1

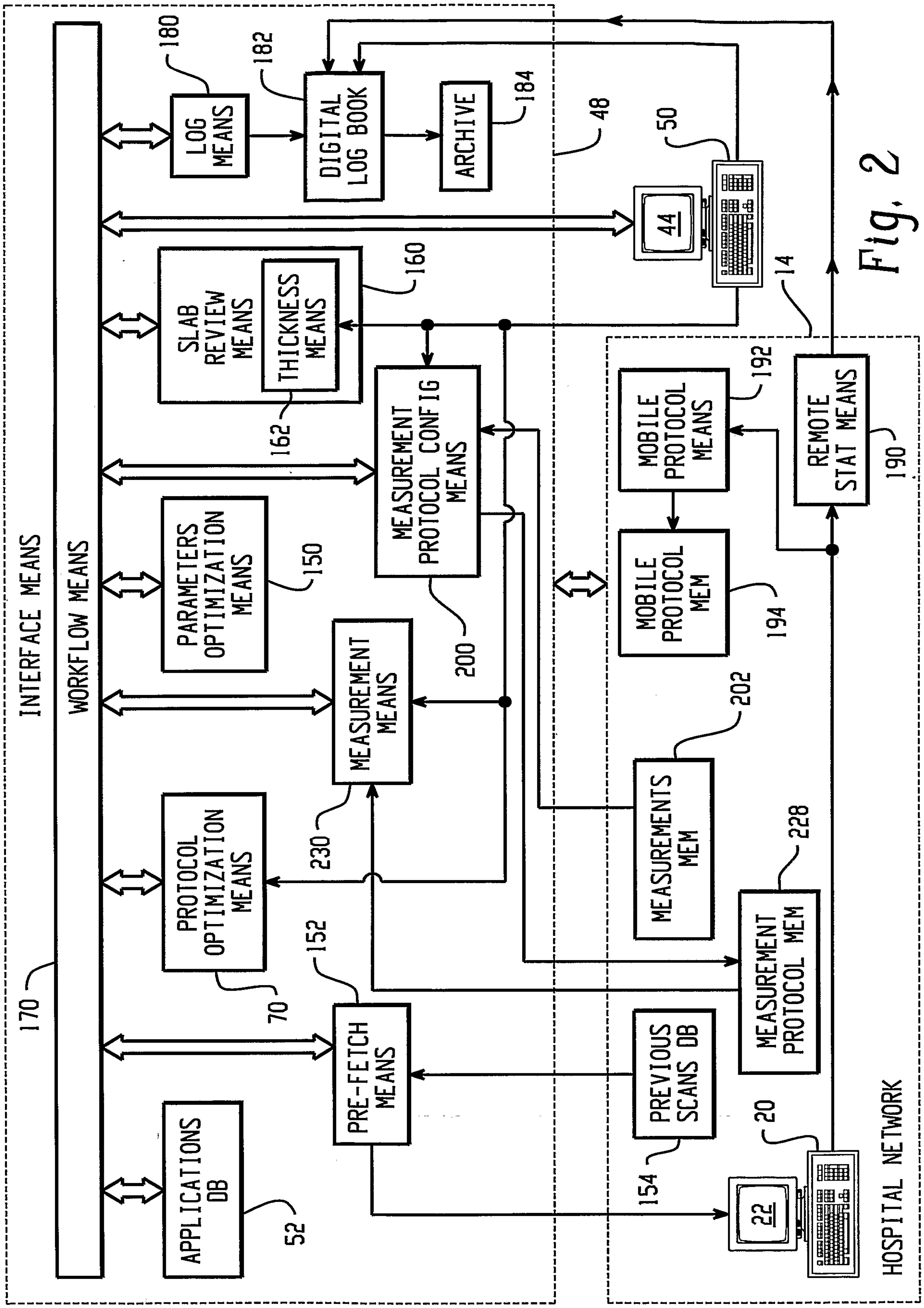
INTERFACE MEANS
WORKFLOW MEANS
170
LOG MEANS
180
DIGITAL LOG BOOK
182
ARCHIVE
184
48
44
50
SLAB REVIEW MEANS
THICKNESS MEANS
160
162
MEASUREMENT PROTOCOL CONFIG MEANS
200
PARAMETERS OPTIMIZATION MEANS
150
MEASUREMENT MEANS
230
PROTOCOL OPTIMIZATION MEANS
70
PRE-FETCH MEANS
152
APPLICATIONS DB
52
14
MOBILE PROTOCOL MEANS
192
REMOTE STAT MEANS
190
MOBILE PROTOCOL MEM
194
MEASUREMENTS MEM
202
MEASUREMENT PROTOCOL MEM
228
PREVIOUS SCANS DB
154
22
20
HOSPITAL NETWORK

Fig. 2

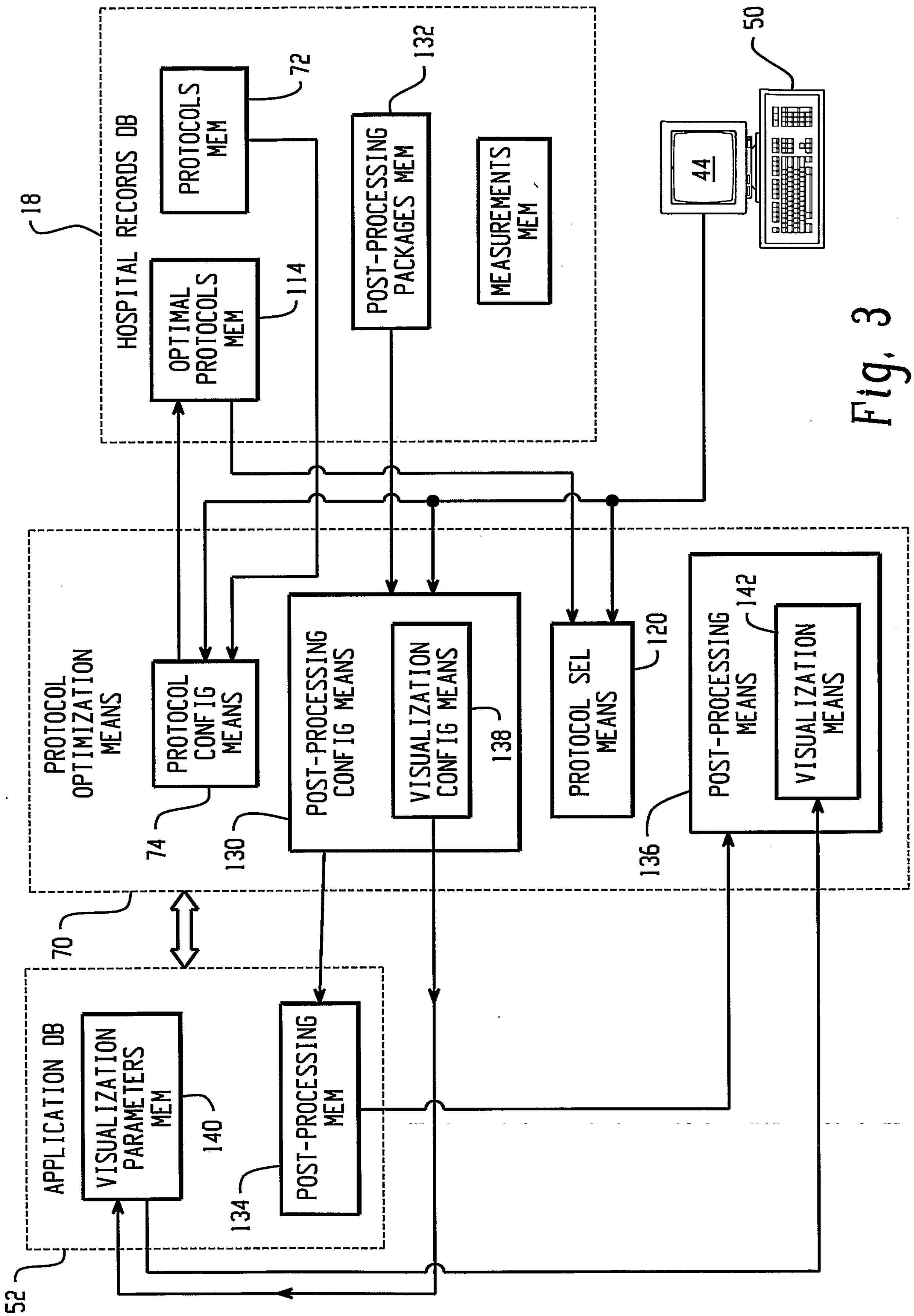
HOSPITAL RECORDS DB
18
PROTOCOLS MEM
72
OPTIMAL PROTOCOLS MEM
114
POST-PROCESSING PACKAGES MEM
132
MEASUREMENTS MEM
44
50
PROTOCOL OPTIMIZATION MEANS
70
PROTOCOL CONFIG MEANS
74
POST-PROCESSING CONFIG MEANS
130
VISUALIZATION CONFIG MEANS
138
PROTOCOL SEL MEANS
120
POST-PROCESSING MEANS
136
VISUALIZATION MEANS
142
APPLICATION DB
52
VISUALIZATION PARAMETERS MEM
140
POST-PROCESSING MEM
134

Fig. 3

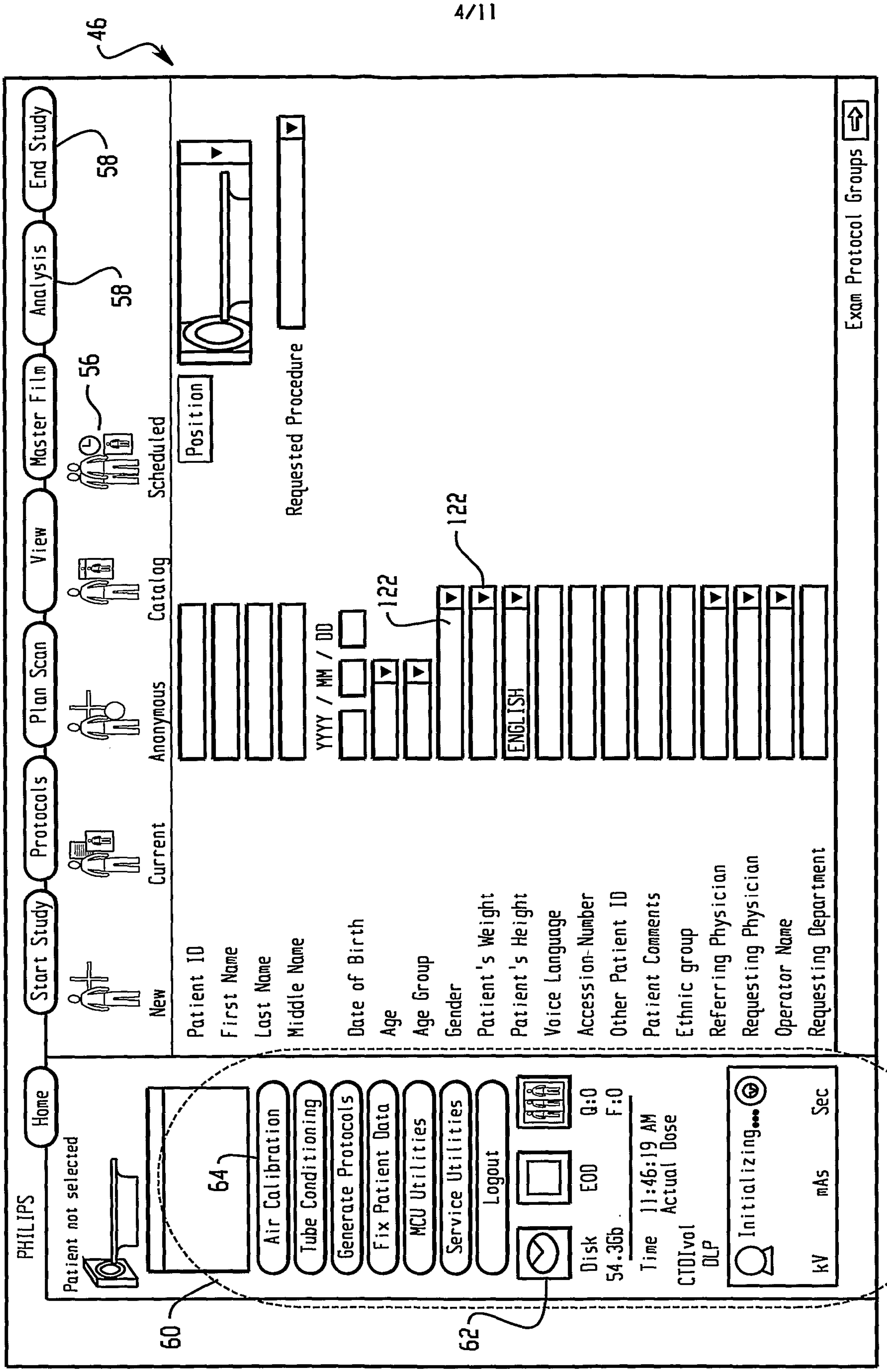
46
PHILIPS
Patient not selected
Home
Start Study
Protocols
Plan Scan
View
Master Film
Analysis
End Study
New
Current
Anonymous
Catalog
Scheduled
56
58
58
Position
Requested Procedure
Patient ID
First Name
Last Name
Middle Name
Date of Birth
YYYY / MM / DD
Age
Age Group
Gender
Patient's Weight
Patient's Height
Voice Language
ENGLISH
Accession-Number
Other Patient ID
Patient Comments
Ethnic group
Referring Physician
Requesting Physician
Operator Name
Requesting Department
122
122
Exam Protocol Groups
Air Calibration
Tube Conditioning
Generate Protocols
Fix Patient Data
MCU Utilities
Service Utilities
Logout
64
Disk
54.3Gb
EOD
Q:0
F:0
Time 11:46:19 AM
Actual Dose
CTDIvol
DLP
Initializing...
kV
mAs
Sec
60
62

Fig. 4

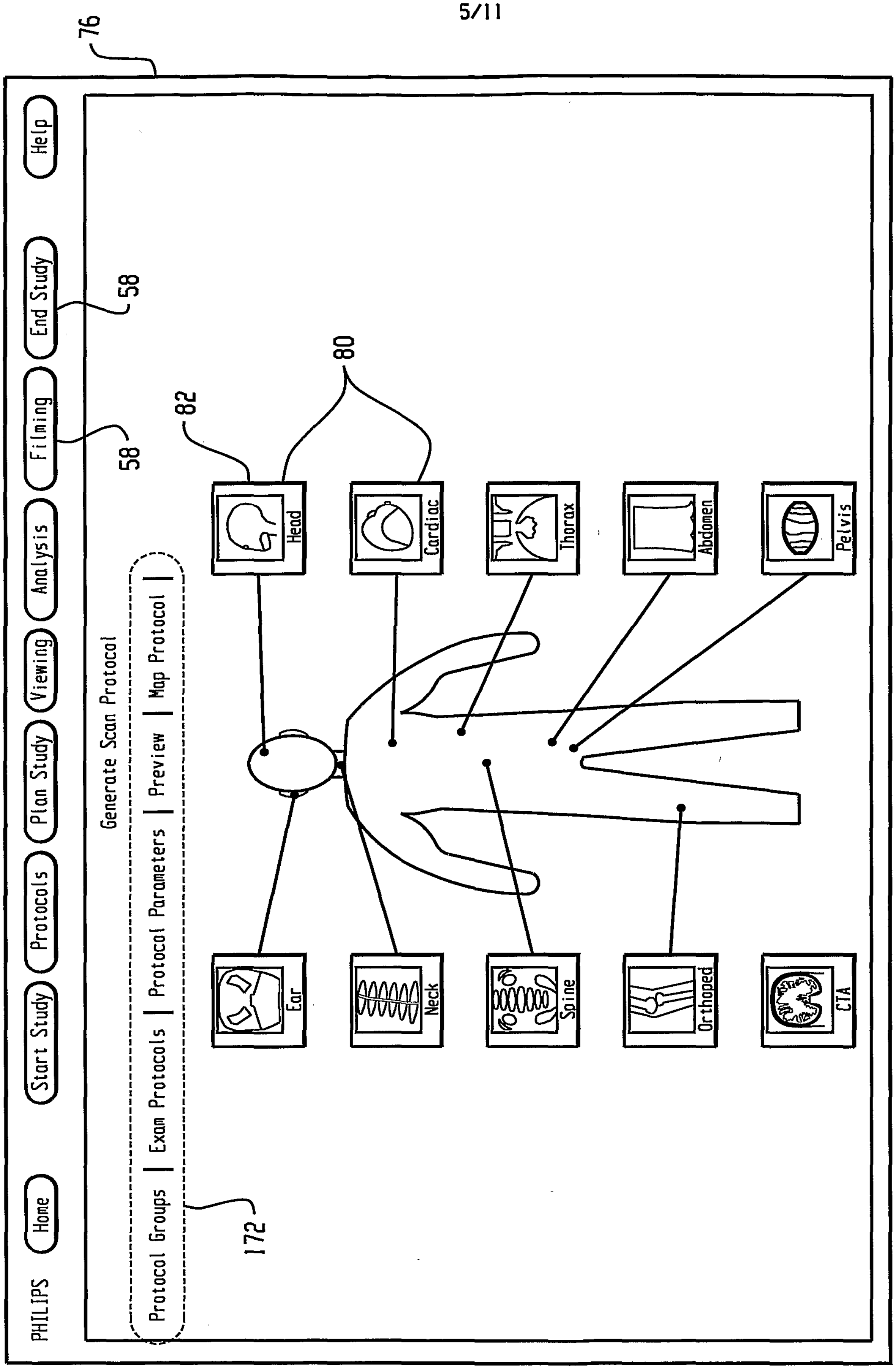
76
PHILIPS
Home
Start Study
Protocols
Plan Study
Viewing
Analysis
Filming
End Study
Help
58
58
Generate Scan Protocol
Protocol Groups | Exam Protocols | Protocol Parameters | Preview | Map Protocol |
172
82
80
Head
Cardiac
Tharax
Abdomen
Pelvis
Ear
Neck
Spine
Orthaped
CTA

Fig. 5

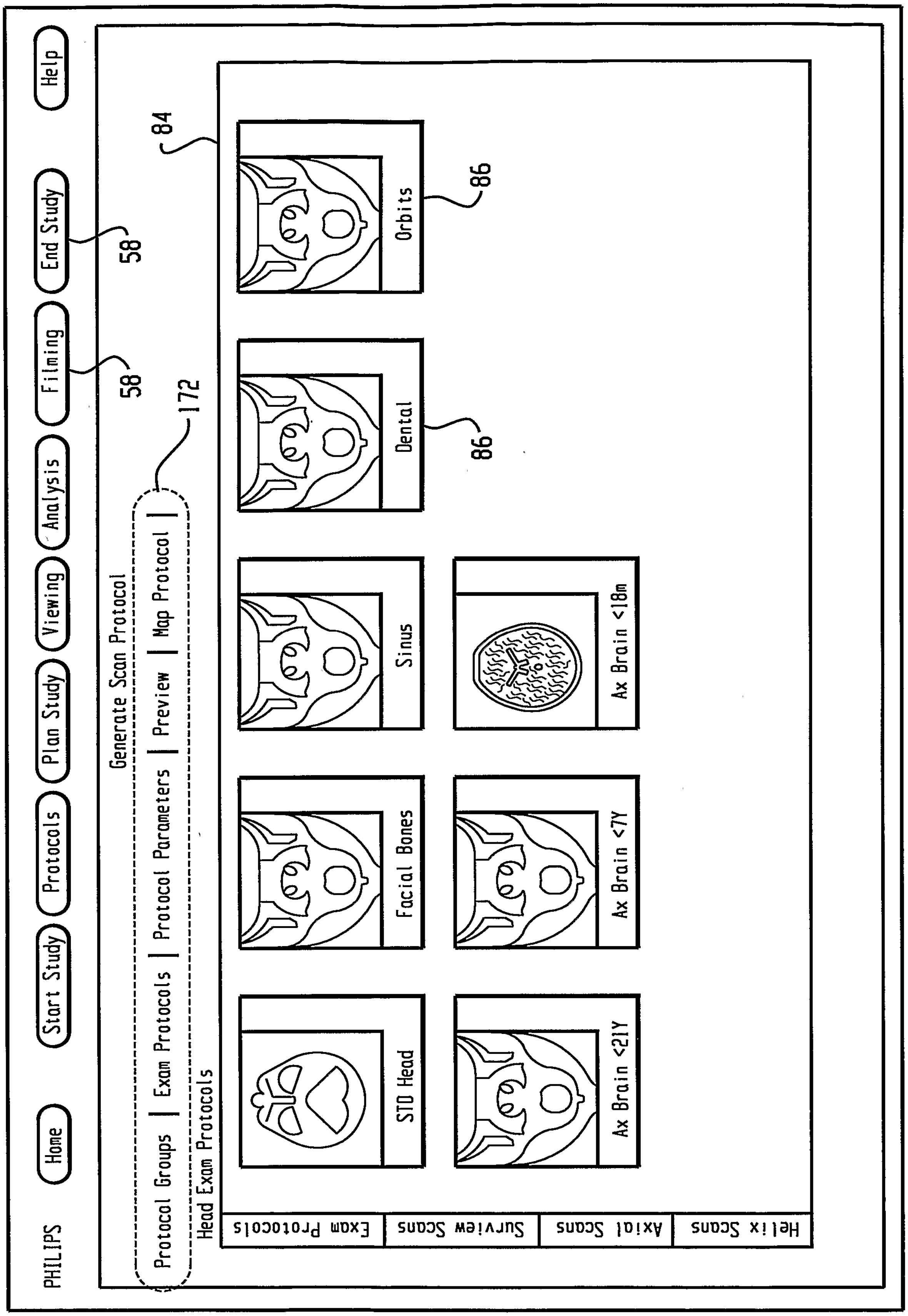
PHILIPS
Home
Start Study
Protocols
Plan Study
Viewing
Analysis
Filming
End Study
Help
58
58
Generate Scan Protocol
Protocol Groups | Exam Protocols | Protocol Parameters | Preview | Map Protocol |
172
84
Head Exam Protocols
STD Head
Facial Bones
Sinus
Dental
Orbits
86
86
Ax Brain <21Y
Ax Brain <7Y
Ax Brain <18m
Exam Protocols
Surview Scans
Axial Scans
Helix Scans

Fig. 6

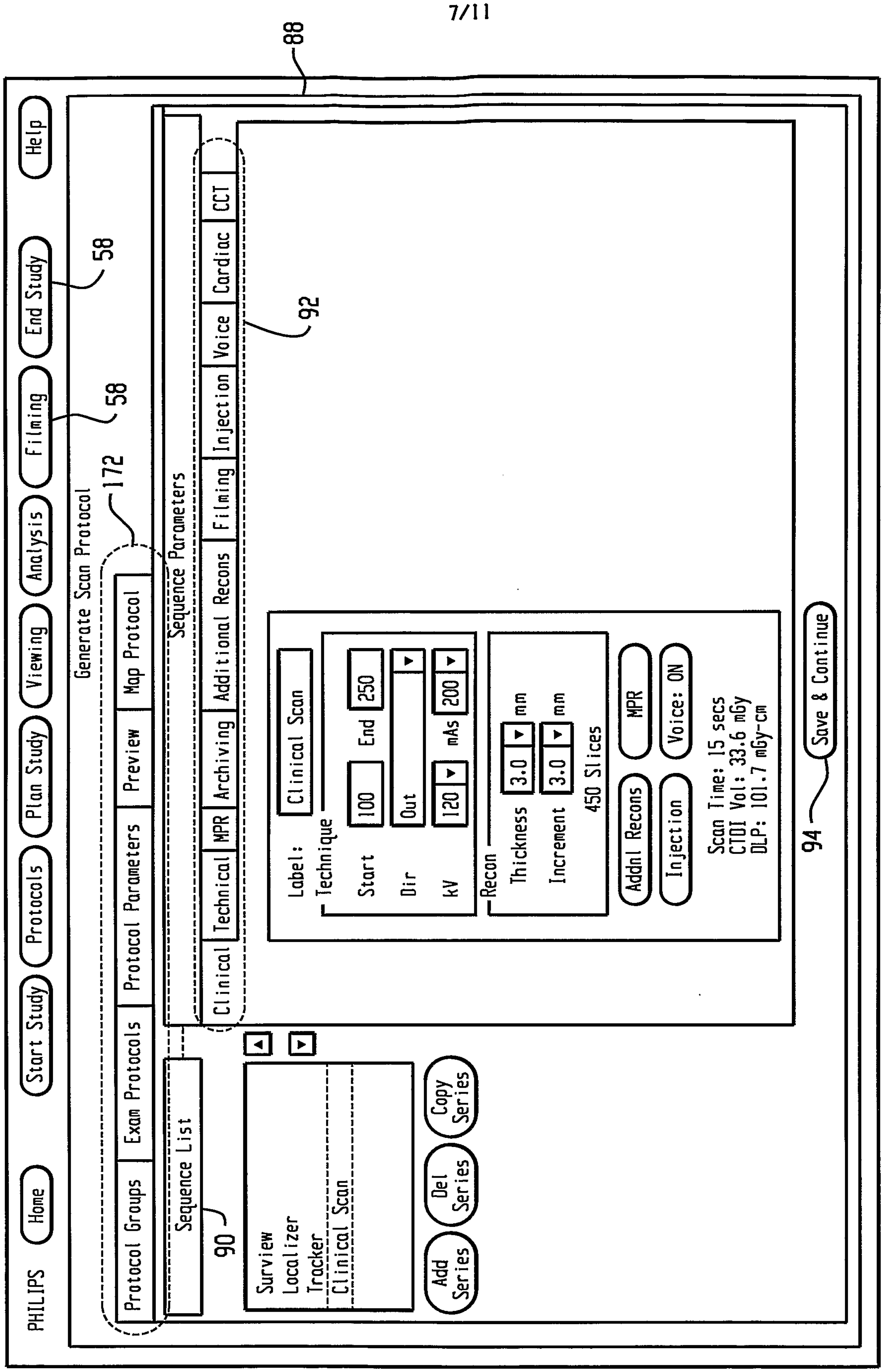
PHILIPS
Home
Start Study
Protocols
Plan Study
Viewing
Analysis
Filming
End Study
Help
58
58
88
Generate Scan Protocol
172
Protocol Groups
Exam Protocols
Protocol Parameters
Preview
Map Protocol
Sequence List
90
Surview
Localizer
Tracker
Clinical Scan
Add Series
Del Series
Copy Series
Sequence Parameters
Clinical
Technical
MPR
Archiving
Additional Recons
Filming
Injection
Voice
Cardiac
CCT
92
Label:
Clinical Scan
Technique
Start
100
End
250
Dir
Out
kV
120
mAs
200
Recon
Thickness
3.0
mm
Increment
3.0
mm
450 Slices
Addnl Recons
MPR
Injection
Voice: ON
Scan Time: 15 secs
CTDI Vol: 33.6 mGy
DLP: 101.7 mGy-cm
Save & Continue
94

Fig. 7

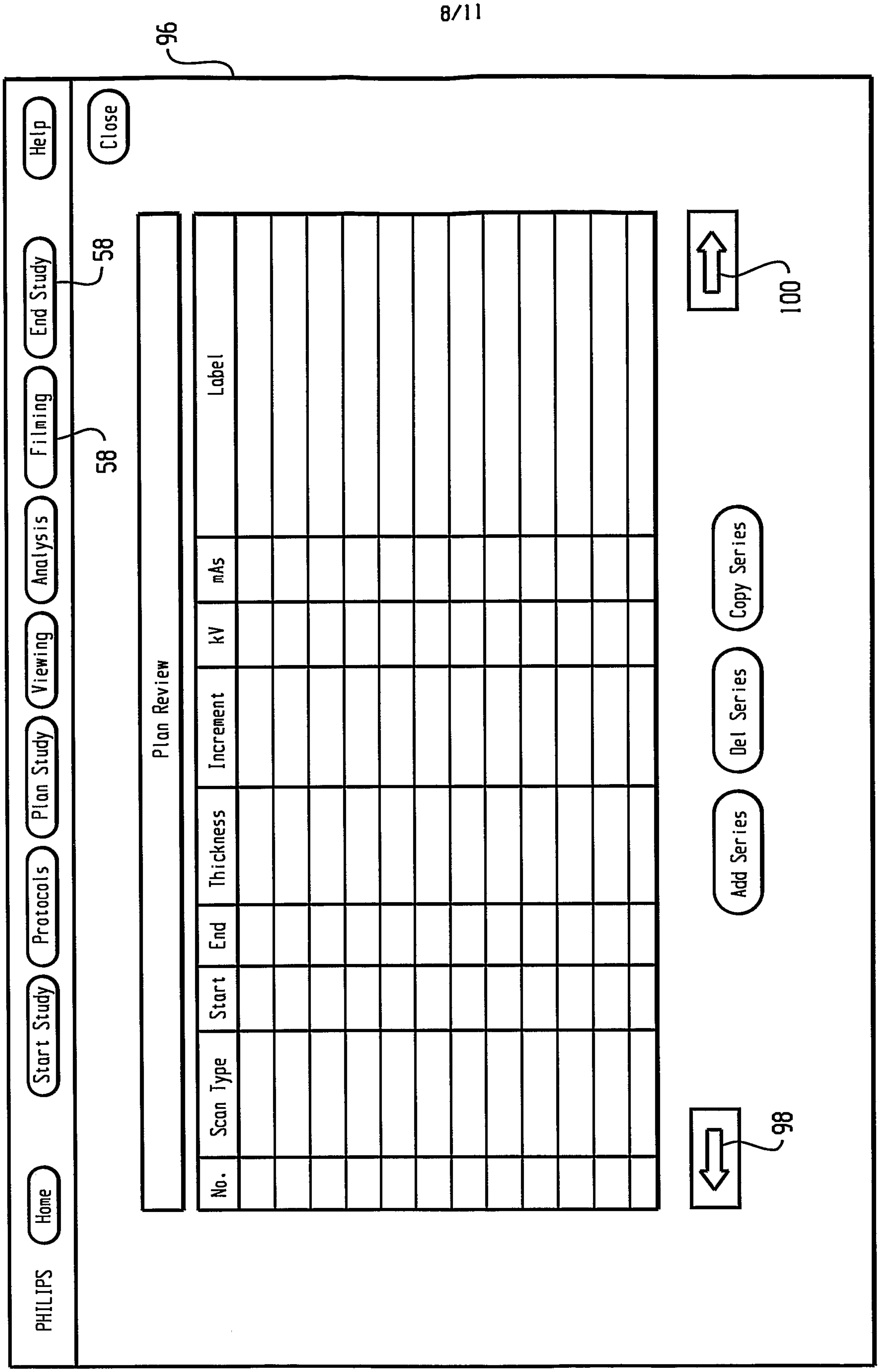
96
PHILIPS
Home
Start Study
Protocols
Plan Study
Viewing
Analysis
Filming
End Study
Help
58
58
Close
Plan Review
No.
Scan Type
Start
End
Thickness
Increment
kV
mAs
Label
Add Series
Del Series
Copy Series
98
100

Fig. 8

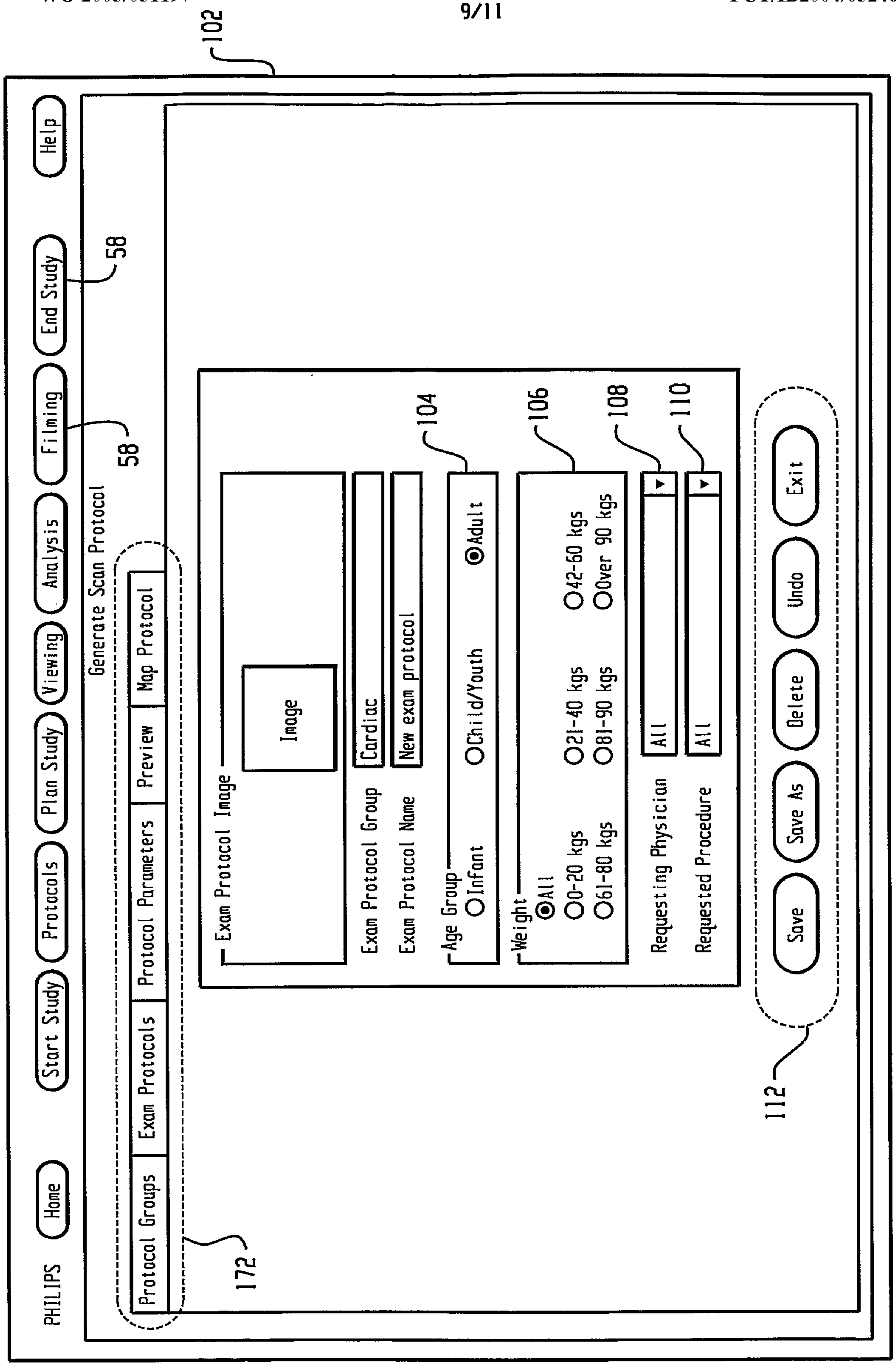
102
PHILIPS
Home
Start Study
Protocols
Plan Study
Viewing
Analysis
Filming
58
End Study
58
Help
Generate Scan Protocol
Protocol Groups
Exam Protocols
Protocol Parameters
Preview
Map Protocol
172
Exam Protocol Image
Image
Exam Protocol Group
Cardiac
Exam Protocol Name
New exam protocol
104
Age Group
Infant
Child/Youth
Adult
106
Weight
All
0-20 kgs
21-40 kgs
42-60 kgs
61-80 kgs
81-90 kgs
Over 90 kgs
108
Requesting Physician
All
110
Requested Procedure
All
Save
Save As
Delete
Undo
Exit
112

Fig. 9

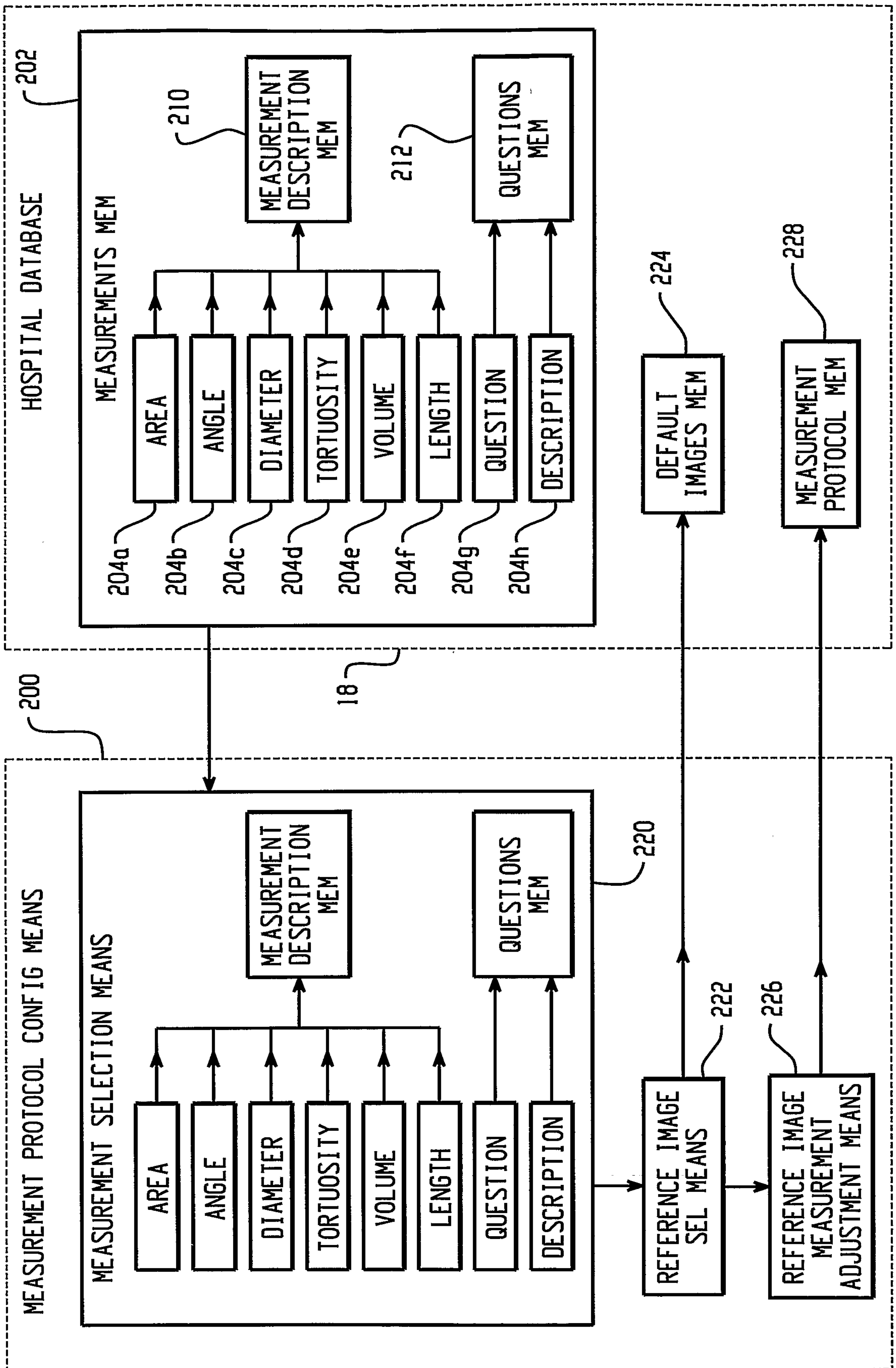
HOSPITAL DATABASE
202
MEASUREMENTS MEM
210
MEASUREMENT DESCRIPTION MEM
212
QUESTIONS MEM
AREA
ANGLE
DIAMETER
TORTUOSITY
VOLUME
LENGTH
QUESTION
DESCRIPTION
204a
204b
204c
204d
204e
204f
204g
204h
224
DEFAULT IMAGES MEM
228
MEASUREMENT PROTOCOL MEM
18
200
MEASUREMENT PROTOCOL CONFIG MEANS
MEASUREMENT SELECTION MEANS
MEASUREMENT DESCRIPTION MEM
QUESTIONS MEM
220
AREA
ANGLE
DIAMETER
TORTUOSITY
VOLUME
LENGTH
QUESTION
DESCRIPTION
222
REFERENCE IMAGE SEL MEANS
226
REFERENCE IMAGE MEASUREMENT ADJUSTMENT MEANS

Fig. 10

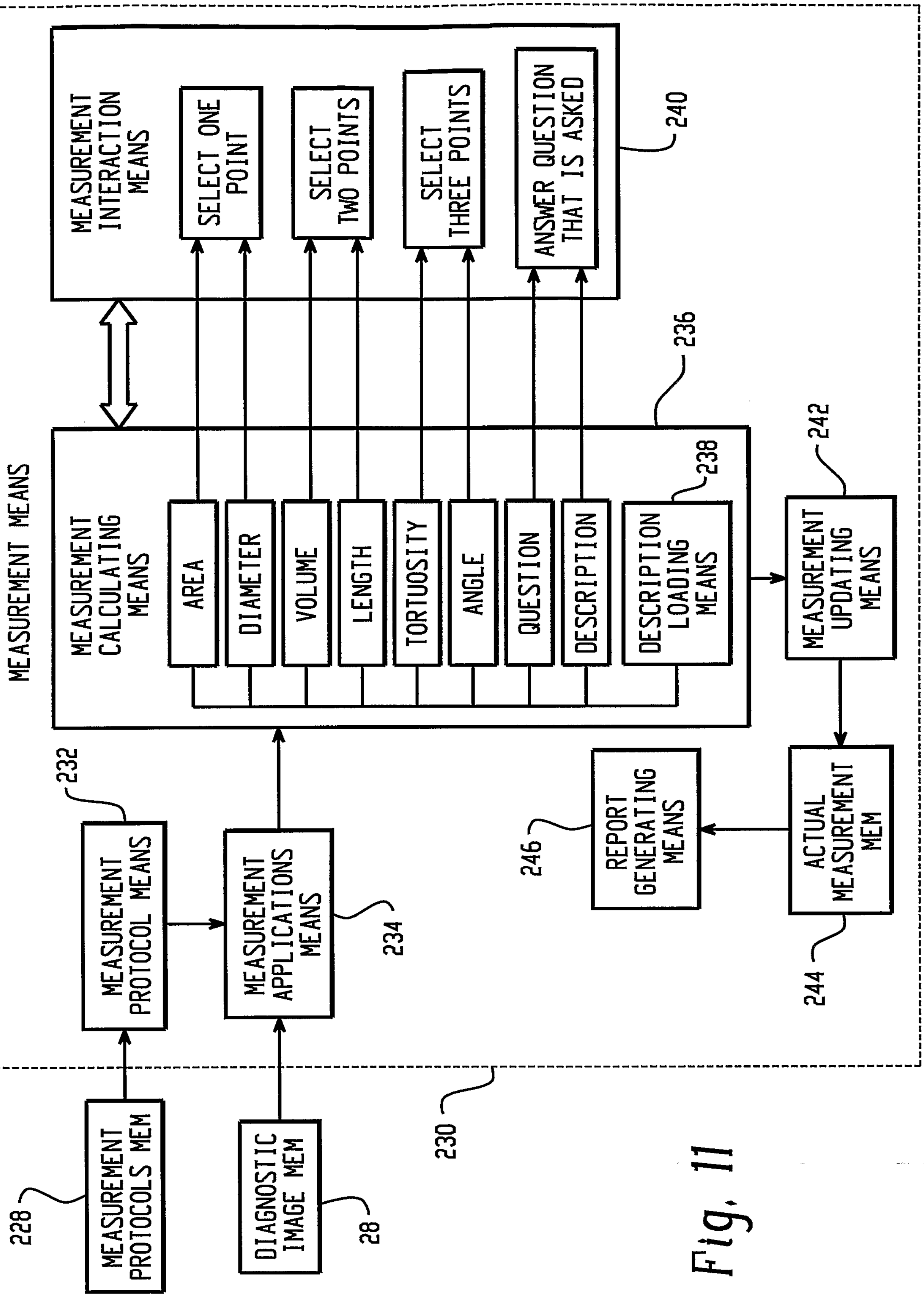
MEASUREMENT MEANS
MEASUREMENT INTERACTION MEANS
SELECT ONE POINT
SELECT TWO POINTS
SELECT THREE POINTS
ANSWER QUESTION THAT IS ASKED
240
236
MEASUREMENT CALCULATING MEANS
AREA
DIAMETER
VOLUME
LENGTH
TORTUOSITY
ANGLE
QUESTION
DESCRIPTION
DESCRIPTION LOADING MEANS
238
MEASUREMENT UPDATING MEANS
242
232
MEASUREMENT PROTOCOL MEANS
MEASUREMENT APPLICATIONS MEANS
234
REPORT GENERATING MEANS
246
ACTUAL MEASUREMENT MEM
244
228
MEASUREMENT PROTOCOLS MEM
DIAGNOSTIC IMAGE MEM
28
230

Fig. 11